CARNIVOROUS PLANT NEWSLETTER

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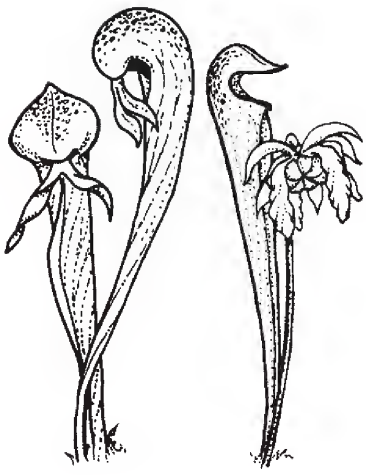

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Front Cover: Two lower pitchers of the recently rediscovered and critically endangered *Nepenthes thorelii* at its only known location in Lo Go-Xa Mat National Park on the Vietnam-Cambodia border. Photo by Richard Nunn. Article on page 93.

Back Cover: Paulo Gonella holding a large specimen of *Drosera magnifica* collected for botanical studies. Notice the long stem, the bifurcated apex, and the plantlet emerging from the base of the stem. Also notice the single candelabra-shaped inflorescence per plant, with multiple flowers. Photo Fernando Rivadavia. Article on page 107.

Carnivorous Plant Newsletter is dedicated to spreading knowledge and news related to carnivorous plants. Reader contributions are essential for this mission to be successful. Do not hesitate to contact the editors with information about your plants, conservation projects, field trips, or noteworthy events. Advertisers should contact the editors. Views expressed in this publication are those of the authors, not the editorial staff.

All correspondence regarding dues, address changes and missing issues should be sent to the Membership Coordinator at the ICPS. Do not send such correspondence to the editors. Checks for subscriptions should be made to the International Carnivorous Plant Society in US funds. Dues, including a subscription, are $30 per year.

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Introducing Alex Eilts

ICPS Board Member and Director of Conservation, Research, and Education

One of the best things about the ICPS is that in addition to being a society of hobbyists who love growing carnivorous plants, the passion for these plants is extended to their conservation. Few plant societies make an active role in the conservation of the focal species a priority. This is one of the things I love most about the ICPS. And, so many members echo this deep commitment to conservation. I'm looking forward to helping further this mission as the Director of Conservation, Research, and Education.

During my doctoral work at the University of Arizona, I was able to explore my concern for conservation as I studied exotic species invasions. Currently, I am at the University of Minnesota, where I work with the plant diversity collection at the College of Biological Sciences Conservatory growing plants for researchers and use in classrooms. I'm also fortunate enough to have opportunities to speak to the broader public about carnivorous plants, where I never miss a chance to highlight the threats many of them face in their native habitats.

I've been growing carnivorous plants on and off for much of my life, frequent moves getting in the way of long-term efforts. Happily, I am now able to grow a range of carnivorous plants totaling around 100 species. I grow a bit of everything, though much of my cultivation effort centers around *Drosera* species. Locally, I was able to help start the Upper Midwest Carnivorous Plant Society to help link hobbyists in the region together.

As the Director of Conservation, Research, and Education I hope to help ensure the money spent will achieve maximum benefit for carnivorous plants, their conservation, and our understanding of them. I'm looking forward to the ICPS formalizing the granting process, updating our conservation statement, and creating materials that can be used in classrooms. The ICPS has a bright future, and I am deeply honored to have the opportunity to participate in steering the path forward.

Pinguicula flowers with pollen imitations close at night – some observations on butterwort flower biology

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Keywords: flower biology, *Pinguicula*, pollination, pollen mimicry, southeastern U.S., Mexico, nastic movement, tropism.

Very little is known about flower biology and pollinators of *Pinguicula*, and even less is published about this topic. I will try to fill at least some small part of this gap by reporting some observations I have made during growing a large number of butterwort species in the greenhouse for almost 20 years, as well as from casual observations made on natural populations during several field trips.

Floral growth and motions during anthesis

The flowers of most *Pinguicula* species will more or less open and close on a daily cycle at very early anthesis (the first few days after they opened from bud), because the corolla (especially the corolla lobes) will slowly enlarge and expand by aid of this growth movement. These so-called nastic movements[1] are exactly the same ecological reaction as observed in other flowers which close at night, e.g. in tulips, where flower closure is achieved by directed, one-sided tepal growth (Hess 1983; Sitte *et al.* 1999). The same basis can be assumed for *Pinguicula*: after re-opening, the butterwort's corolla will be slightly larger every morning, until it has reached final size at the end of what could be termed "floral enlargement stage" (that is, at top of anthesis, a maturity stage, when pollen is ripe and the stigma is receptive; in a few *Pinguicula* species, this even goes along with a slight change of flower color, most notably in *P. mirandae*, where the flowers are white in bud and as long as they are in enlargement stage, but they turn pale pink as soon as they are fully sized at maturity stage). At maturity stage of anthesis, the corolla will become immobile and remains open and held at about the same orientation during day and night for the majority of *Pinguicula* species – all except the five species from the southeastern U.S. (*P. caerulea*, *P. ionantha*, *P. lutea*, *P. primuliflora*, and *P. pumila*) and *P. debbertiana* from Mexico (most notably in the white-flowered form of this species). These six species have flowers that keep closing and turning downwards every night, until the corolla finally fades and is shed (although the movement happens to a much lesser extent in aged flowers). While the former five are a group of closely related species forming a natural affinity (*P.* section *Isoloba*; Casper 1966) which evolved from a common ancestor (they constitute a monophyletic lineage; Cieslack *et al.* 2005; Degtjareva *et al.* 2006), *P. debbertiana* is only distantly related to them: this species belongs to the Central American *Pinguicula* clade, members of which have been formerly assigned to various sections. All remaining members of that Mexican affinity (e.g. *P. ehlersiae*, *P. agnata*) have flowers that remain open all day and night. Interestingly, the phenomenon of nocturnal flower closure of certain *Pinguicula* species has not been documented thus far, except

[1] Often, plant movements are commonly called "tropisms", however a tropism is always a direction-dependent response towards the stimulus – e.g. the closure of the snap traps of *Dionaea* or the tentacle movement of *Drosera* upon mechanical and/or chemical prey stimuli, while a nastic movement is a non-directional reaction of the plant – e.g. nocturnal closure of flowers.

Figure 1: "Sleeping" flowers of *Pinguicula debbertiana* (a pale rose-flowered form), photo taken during the night (ca. 2 a.m.) in the greenhouse. For comparison, the flowers of *P. ehlersiae* (species closely related to *P. debbertiana*) do not close at night. The single flower of *P. debbertiana* on the far left which is more open is aged and does not show much of the nocturnal nastic movement anymore.

a single passing mention in a field trip report by Gluch (2005), who states about a population of *P. ionantha* at Franklin County that "[d]ue to the fact that it was still early in the morning the plants were just opening their flowers."

The "sleeping position" of the flowers of the above-mentioned six species is reached by two different growth movements: Not only do the lobes of the corolla upper and lower lip fold inwardly to overlap and cover the tubular part of the corolla, but also the upper part of the flower scape bends downwards (again, this is a growth movement, as the peduncle elongates during this movement), so that the closed flowers are nodding during night (Fig. 1). The movement of flower closure starts with fading light at dusk, and the flowers will be fully closed about 1-2 hours after sunset in the greenhouse. In the morning, the corollas will slowly start to open again about one hour after sunrise. I have observed this rhythm in the greenhouse (where additional nocturnal cooling and condensation come closer to natural conditions), but also – yet less pronounced – in plants grown indoors under artificial lights (12 hours of light), and even in plants cultivated on a windowsill at more balanced room temperature. However, I was able to prevent closure of flowers of *P. primuliflora* and *P. debbertiana* in a setup under artificial lights running for 24 hours. Thus I assume light change is the primary ecological stimulus to cause the nastic movement (a so-called photonastic movement), howev-

er a supporting temperature-dependent reaction of course cannot be excluded (both temperature and light have been found as ecological stimuli to cause nocturnal flower closure in plants: thermonastic closure of flowers is known, e.g. in tulips, crocus and daisies, while photonastic movement is the cause for flower closure in gentians, water lilies, and cacti, or the opening of nocturnally blooming *Silene* species; Sitte *et al.* 1999). The movement itself is temperature dependent, as the flowers are open earlier on warm, sunny days (whereas the corollas take much longer, about 3-4 hours after sunrise, to fully open on cool, humid, and dull days) – this is reasonable, as the movement itself is caused by growth, which is temperature-dependent in plants, which are poikilothermic organisms.

So why do the flowers of these six species show this nocturnal "sleeping behavior"? For other plants, one reason for flower closure at night is explained by protection of the flower interior (especially the receptive stigma and the dry pollen) from getting wet and inactive by nocturnal condensation (Hess 1983). And indeed, usually these types of flowers will also remain closed on dull, overcast days, or will even close during rain (for example the upright, tubular flowers of many gentian species will already start to close when in shade of a cloud for a few minutes; Sitte *et al.* 1999; pers. obs.). But the situation in *Pinguicula* seems to be different, and I would reject this explanation for the genus, because the upright, tubular flowers as present in many other species of butterworts will not close at night (e.g. *P. agnata*, *P. pilosa*, or *P. ibarrae* all have open, tubular flowers facing sky, nevertheless they do not close at night or during rain; the comparatively open flowers of *P. alpina* are often found "flooded" with rain in the species' alpine habitats with frequent rain and fog; the same holds true for all other *Pinguicula* species from all sections, except the six above-mentioned species). So, why are these six species showing nocturnal floral motions? It would seem that the conventional explanations for the nightly sleeping pose for these flowers are not successful. At the end of this article, I will propose another hypothesis of why floral sleeping behavior has evolved in exactly these six species. But to get to this conclusion, we will first have to consider a few other features of *Pinguicula* flowers and floral biology.

Pollen dummies and floral cheating

What these six above-mentioned *Pinguicula* species have in common, apart from nocturnal flower closure, is that their flowers show a conspicuous, yellowish, whitish, or greenish, hairy mark protruding from the base of the lower lip, near the corolla entrance (Fig. 2). Quite obviously, these structures serve as stamen or pollen mimicry, i.e. "pseudopollen" lures to attract specific pollinators. However these *Pinguicula* flowers are not rewardless, deceptive flowers, like those of some orchids – all butterworts produce a certain amount of nectar at the tip of their spur as a pollinator reward, including the six species mentioned above (pers. obs.) – their stamen/pollen imitations seems to constitute simply an additional attractive clue to the pollinators, and maybe also prevent the pollinating insects from trying to feed on the real pollen of the plant. In the five southeastern U.S. species, the pollen mimicry goes along with an almost radial (actinomorphic) appearance of the usually zygomorphic butterwort corolla: there is no evident bilabiate shape of the corolla in the upper and lower lobe (compared to most other *Pinguicula*), as all five corolla lobes are almost identical in shape and size – hence the sectional name *Isoloba*, which means "equal lobes". Additionally, their flowers have a more or less upright position of the corolla entrance (the open corolla tube is facing sky) – these flowers quite obviously resemble flowers of other, accompanying plant species (some of which offer rich pollen load to their pollinators), such as Ericaceae or Melastomataceae (e.g. *Rhexia*) or *Polygala* (milkweed). Its superficial resemblance with primrose (*Primula*) flowers even led to the specific name of one species, *P. primuliflora*.

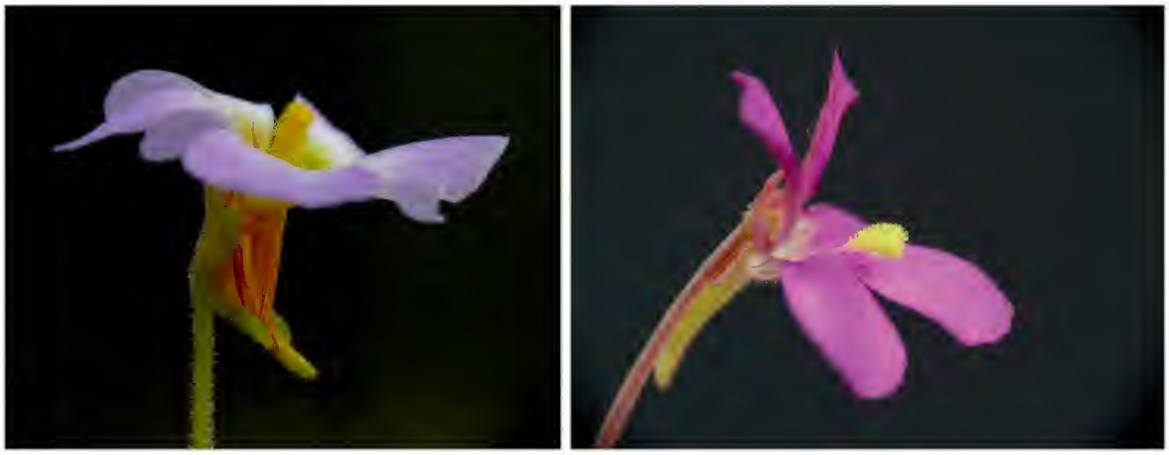

Figure 2: The conspicuous yellow to whitish, hairy pollen imitations found at the corolla tube entrance of certain *Pinguicula* species are sterile outgrowths of the corolla palate. The two true stamens of the butterworts are hidden deeply inside on back of the corolla tube interior. These pollen imitations evolved in parallel at least twice in the genus, and are found in all five species of the southeastern U.S. Pictured is *P. primuliflora* (left) and in the only distantly related *P. debbertiana* from Mexico (right).

Interestingly, the orchid genera *Calopogon* (grass pink) and *Pogonia* (pogonia), both which are frequently occurring in the same bog habitats as the five *Pinguicula* species of the southeastern U.S., also have similar stamen/pollen dummies: they display a brush of yellow hairs on the labellum (lip), which mimic pollen. In contrast to *Pinguicula*, *Calopogon* has deceptive flowers not offering any reward to their pollinators (the flowers are nectar-less and the orchid pollinia cannot be consumed by the pollinating insects; Thien & Marcks 1972; Hess 1983; Argue 2012). Apparently, the local pollinators can be easily cheated, as quite unrelated plants apply a similar deceit strategy in the same habitat. While trying to feed/collect this false pollen, the pollinator will pollinate the flower, by touching stigma and anthers, which are hidden inside the corolla tube over the pollinator's head. In *P. debbertiana*, however, the corolla is distinctly bilabiate, and the flowers are held more or less horizontally (while other Mexican species of this affinity have nearly radially symmetrical flowers facing straight upwards, e.g. *P. rotundiflora*, yet they all lack that conspicuous, 3-dimensional pollen mimic which is uniquely found in *P. debbertiana* from that Mexican affinity). However, almost all *Pinguicula* species show one or more contrasting color marks at the base of the corolla lower lobe – the so-called palate – at the entrance to the throat (so-called bulls-eye or nectar guide patterns), and this part of the corolla throat is additionally lined by very specific, club-shaped multicellular glandular hairs (so-called "futterhaare" or "feeding hairs", see Fig. 3). These are situated on and near the color marks on the palate of all but a few species (one notable exception is the Mexican *P. ehlersiae*, where this part of the corolla is almost glabrous), and their shape and distribution pattern is so unique and often species-specific, that the character of corolla throat indumentum can be used for species identification alone (Wood & Godfrey 1957; Godfrey & Stripling 1961; Casper 1966). From an evolutionary aspect, these hairy nectar guides could represent a pre-adaptation to pollen mimicry – and indeed, I have observed on several occasions various dipterans (Muscidae, Empididae, Bombyliidae, and Syrphidae) dabbing with their proboscis at the yellow spots on the otherwise white corolla of *P. alpina*, and on the white corolla marks on the violet corolla of *P. vulgaris* and *P. leptoceras* in the European Alps, as if they tried to find nectar or pollen there (Fig. 4).

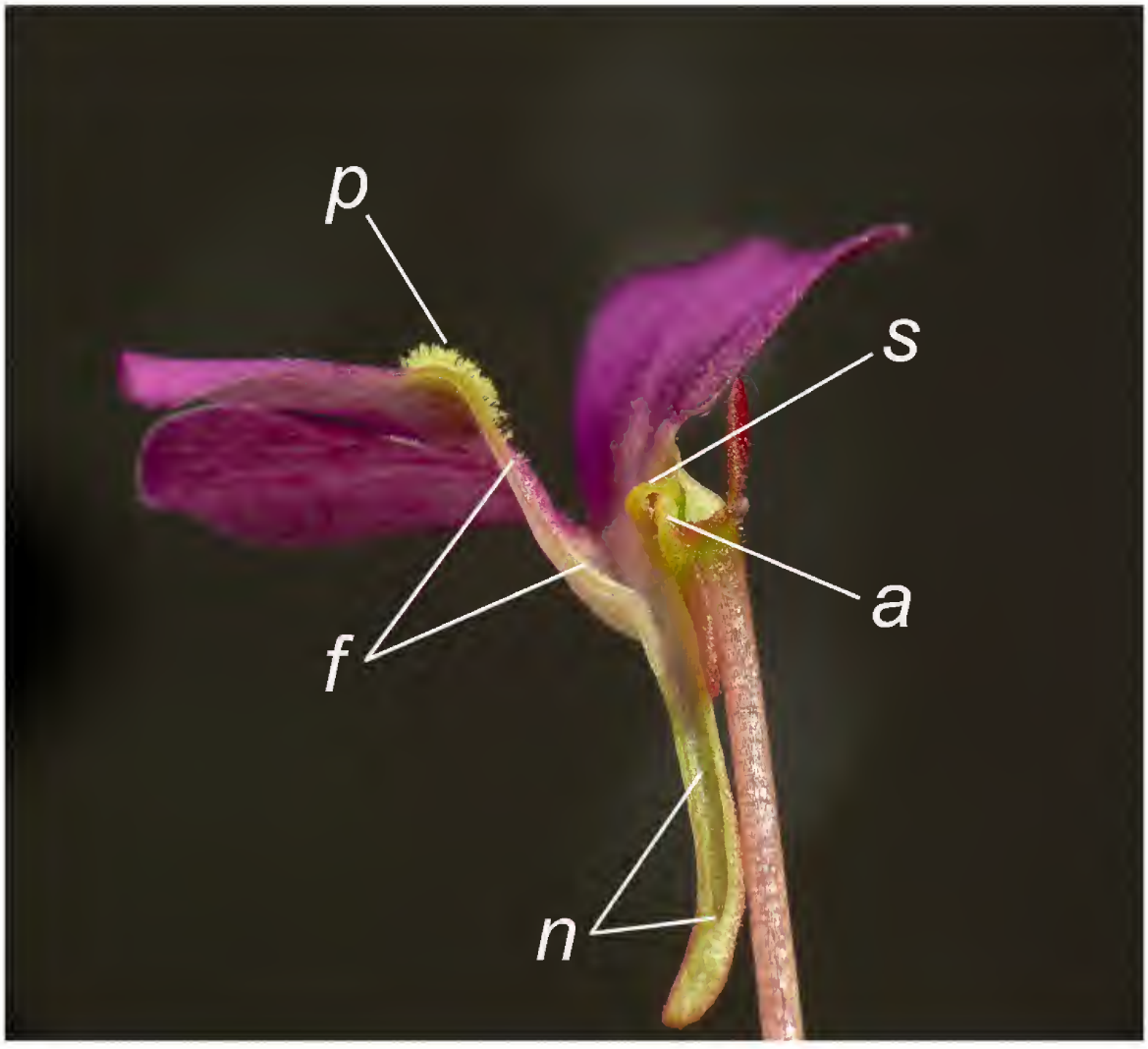

Figure 3: Longitudinal section of a flower of *Pinguicula debbertiana*. *a* = one of the two anthers housing the pollen, *s* = the two lobed stigma, the lower lobe's rear is covering the pollen sacs of the anthers, *f* = feeding hairs, *p* = pseudopollen lure (an outgrowth of the palate at the base of the corolla lower lip's median lobe), *n* = nectar-producing glands inside the spur.

Butterwort pollination and pollinators, insects, and deceit flowers

Reports on natural pollinators of *Pinguicula* are rare, and predominately focus on the European species (e.g. Müller 1881; Molau 1993). Some of the Central American species with bright reddish, large flowers and wide, straight spur have been connected to hummingbird pollination (e.g. *P. laueana*, *P. hemiepiphytica*; Lampard *et al.* 2016), yet this does not account for the Mexican *P. debbertiana*, and for most Mexican species, no pollinator observations have been made until today.

Like the majority of *Pinguicula* species I have been growing and studying in the greenhouse, the six pollen-mimic species discussed here are not able to self-pollinate (the complex arrangement of anthers and bilabiate stigma generally favors cross-pollination in Lentibulariaceae – but the majority of species can be artificially selfed with their own pollen), thus will require pollinator visits in order to set seed in the wild. This agrees with Annis *et al.* (2014), who studied *P. ionantha* in natural habitat – unfortunately, they did not observe natural pollinators, but concluded that pollen vectors are

Figure 4: Species of dagger fly (Diptera: Empididae) first erroneously trying to feed from the white eye-spot of a *Pinguicula leptoceras* flower with its long proboscis (left), then entering the corolla tube guided by the feeding hairs to reach the spur-borne nectar (right). Ötztal Alps, Tyrolia, Austria.

necessary for successful fruit set. A hoverfly (Diptera: Syrphidae) has been observed and pictured in Florida by Makoto Honda in 2008 while it was trying to feed on the false pollen displayed on the corolla of *P. ionantha* (Fig. 5). Syrphids trying to feed on the pollen imitations of the southeastern U.S. species have casually been observed (Th. Franke pers. comms.), and this is quite likely, because syrphid flies are generalist flower visitors, feeding on pollen and nectar of a wide range of plants. And syrphids are also among the known pollinators of certain *Pinguicula* species (reports from the European species only: Müller 1881; Molau 1993). However, they are unlikely to be the main pollinators of the southeastern U.S. species, as they will not enter the corolla tube while dabbing at the false pollen with their mouth parts (Fig. 5). Hence, they will not get in contact with stigma and stamens (which house the real pollen), which are deeply hidden inside the corolla tube (see Fig. 3). Therefore, short-tongued syrphids can be considered casual or even frequent floral visitors of these species, but not their actual or regular pollinators. The entire habit of the flowers (with comparatively thick, robust scapes – especially in *P. lutea* and *P. caerulea*; and freely exposed, visually attractive pollen imitation, and a nectar reward that is hidden deeply at the tip of the spur) makes it quite likely to assume long-tongued larger bees, like bumblebees (*Bombus* spp.) or other large to medium-sized native bees (e.g. Anthophoridae) to be the main natural pollinators of the southeastern U.S. butterwort species. The introduced European honey bees are also able to handle the flowers of the southeastern U.S. *Pinguicula* species (Fig. 5). Schnell (2002) assumes small native bees as natural pollinators, however these could also have sought the flowers as nocturnal roost; this behavior is well known from several bee genera, and especially common in male bees which are often found roosting in tubular flowers, e.g. bellflowers, but also various other flowers which close at night. Especially freshly hatched *Bombus* workers will try a lot of different flowers when foraging for pollen and nectar, and these still "inexperienced" bumblebee workers have been found to be the main pollinators of deceit orchid flowers using pollen imitations in the southeastern U.S. (*Calopogon*, *Pogonia*, *Arethusa*; Thien & Marcks 1972; Heinrich 1975). The workers test these flowers, until they have learned that they will get no pollen reward, and will finally avoid them. In the five *Pinguicula* species, the situation might be slightly different: the pollinator will also experience frustration when foraging for pollen and trying to collect from the imitations, but it will get at least nectar as a reward from these flowers.

Figure 5: The hoverfly *Toxomerus marginatus* (Diptera: Syrphidae; species identified by Ximo Mengual) trying to feed on the yellow pollen imitation on the corolla palate of *Pinguicula ionantha* in Florida (left) and European honey bee (*Apis mellifera*; Hymenoptera: Apidae) nectar-feeding on a flower of *Pinguicula lutea* (right). Photos by Makoto Honda, with kind permission.

Flower colors and breeding system

The flower color variation observed in some populations of the deceptive orchid *Calopogon* has been interpreted as an evolutionary strategy applied by the plants to avoid "learning effects" by the frustrated bumblebees looking for pollen (Heinrich 1975). Indeed, deceptive flowers often show a broad range of coloration and/or flower scent within a single species, in order to minimize that pollinators will learn to avoid a certain flower sight. To which extent this is also true for the "pollen-mimicking" but nectar-rewarding *Pinguicula* species is not clear – at least populations of *P. pumila* are extremely variable in terms of corolla color, size, and shape (Schnell 2002). However, this is most likely connected to the annual life strategy and of the species, in combination with the necessity for outbreeding (flowers of *P. pumila* will not self without artificial pollination, at least not in cultivation). Outbreeders might show more floral variation than congeneric species with the capability for selfing (Lin & Ritland 1997; Fishman *et al.* 2002) – and this apparently also holds true for annual *Pinguicula* species: the annuals *P. pumila* and *P. filifolia* are both not able to self (pers. obs.), hence are in need of flower visitors (or hand-pollination by the grower) to set seed, and both species show a remarkable variation of corolla shape and color within their natural populations (Schnell 2002; Domínguez 2012; Domínguez *et al.* 2014). On the other hand, the annual species *P. lusitanica*, *P. takakii*, and *P. sharpii* are faculatively autogamous, and even without pollination all flowers will self and set seed (pers. obs.) – populations of these three species are relatively uniform in terms of flower shape and color throughout their range. The annual *P. lilacina* is a special case, as plants from some locations will automatically produce seed from selfing in cultivation, while others don't (pers. obs.; M. Welge pers. comms.) – which might explain that there is certain, local flower variation observed in this species (Casper 1966).

As mentioned above, *P. debbertiana* is only distantly related to the five southeastern U.S. species, hence a pollen mimicry has evolved at least twice independently in the genus. And coincidentally, a nocturnal closure of the flowers also has developed in parallel in these species. It is quite reasonable to assume a causal connection here, corroborated by the fact that in *P. debbertiana* a slightly different way of corolla closure is applied to achieve the same result, namely a flower tube that cannot be entered at night. Little is known about the natural pollinators of the five southeastern U.S. species (only a few casual floral visitors have been reported so far), and nothing at all regarding pollinators of *P. debbertiana* in Mexico. However, the visual guide of the pollen dummy makes it reasonable to assume diurnal pollinators, probably pollen feeders (such as some diptera, like hoverflies, Syrphidae), or pollen collectors (i.e. bees, Apidae). The hidden nectar offered at the tip of the spur can only be reached by long-tongued insects (like Diptera and Apidae; both have been observed as flower visitors and pollinators in other species of *Pinguicula*; Müller 1881; Molau 1993; pers. obs.; Fig. 4), therefore I would exclude most other insects, such as pollen-feeding beetles as possible pollinators. Anthophilous beetles would also leave their traitorous traces on the corolla, such as gnaw marks and claw marks – however most Mexican *Pinguicula* flowers look relatively undamaged in habitat (see Lampard *et al.* 2016). Yet, perhaps pollen-feeding beetles are not attracted to the "normal" butterwort flower, which has its pollen reward hidden inside the corolla? But do certain nocturnal insects (e.g. certain herbivorous beetles) perhaps cause a potential threat to the pollen dummy of these six *Pinguicula* species, and therefore they hide their conspicuous corolla outgrowths at night? Or do these species just want to protect their nectar from nocturnal flower visitors? If the latter was the case, then why is the trait of nocturnal corolla closure not found in any other butterwort species – and why would a nocturnal insect be an inferior pollinator than a diurnal one? Or, maybe also another likely reason, the nocturnal closure serves to exclude pollinators that are active in the early morning, or to prevent them from learning about the false pollen display too quickly – if other plants with a similar, yet real pollen display are visited first (because the cheaters still have their flowers closed), then this character display will be recognized by the pollinating insects as "reward", and they will perhaps search for similar flowers more readily. However, if the first few flowers tested for pollen all proved to be "frustration", then it is likely that the insect might avoid this kind of flower sight for the rest of the day (the sympatrically growing orchids mentioned above have their flowers opened day and night, but would perhaps compensate this by the much longer anthesis time). Detailed field studies on flower ecology of the southeastern U.S. *Pinguicula* species, and on *P. debbertiana*, in natural habitat will be necessary to finally solve these questions – perhaps this article could serve as an incentive to conduct some field studies on the subject? So little is known about the flower biology of most carnivorous plants, thus I would like to encourage you to share your observations.

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References

Annis, J., Primer, S.B., Molano-Flores, B., Coons, J., and Feist, M.A. 2014. Pollination requirements and self-compatibility of Godfrey's butterwort, *Pinguicula ionantha* (Lentibulariaceae). Poster at the 2014 Botany Conference, Boise, Idaho.

Argue, C.L. 2012. The pollination biology of North American orchids: Volume 2: North of Florida and Mexico. Springer, New York.

Casper, S.J. 1966. Monographie der Gattung *Pinguicula* L. Bibliotheca Botanica 127-128: 1-209.

Cieslack, T., Polepalli, J.S., White, A., Müller, K., Borsch, T., Barthlott, W., Steiger, J., Marchant, A., and Legendre, L. 2005. Phylogenetic analysis of *Pinguicula* (Lentibulariaceae): chloroplast DNA sequences and morphology reveal several geographically distinct radiations. American Journal of Botany 92: 1723-1736.

Degtjareva, G.V., Casper, S.J., Hellwig, F.H., Schmidt, A.R., Steiger, J., and Sokoloff, D.D. 2006. Morphology and nrlTS phylogeny of the genus *Pinguicula* L. (Lentibulariaceae), with special attention to embryo evolution. Plant Biology 8: 778-790.

Domínguez, Y. 2012. Alla ricerca delle pinguicole di Cuba occidentale. AIPC Magazine 27: 10-35.

Domínguez, Y., da Silva, S.R., Panfet Valdés, C.M., and de Miranda, V.F.O. 2014. Inter- and intraspecific diversity of Cuban *Pinguicula* (Lentibulariaceae) based on morphometric analyses and its relation with geographical distribution. Plant Ecology & Diversity 7: 519-531.

Fishman, L., Kelly, A.J., and Willis, J.H. 2002. Minor quantitative trait loci underlie floral traits associated with mating system divergence in *Mimulus*. Evolution 56: 2138-2155.

Gluch, O. 2005. *Pinguicula* species (Lentibulariaceae) from the southeastern United States: observations of different habitats in Florida. Acta Botanica Gallica 152: 197-204.

Godfrey, R.K., and Stripling, H.L. 1961. A synopsis of *Pinguicula* L. (Lentibulariaceae) in the southeastern United States. American Midland Naturalist 66: 395-409.

Heinrich, B. 1975. Bee flowers: a hypothesis on flower variety and blooming times. Evolution 29: 325-334.

Hess, D. 1983. Die Blüte. Ulmer, Stuttgart.

Lampard, S., Gluch, O., Robinson, A., Fleischmann, A., Temple, P., McPherson, S., Roccia, A., Partrat, E., and Legendre, L. 2016. *Pinguicula* of Latin America. Redfern, Dorset.

Lin, J.-Z., and Ritland, K. 1997. Quantitative trait loci differentiating the outbreeding *Mimulus guttatus* from the inbreeding *Mimulus platycalyx*. Genetics 146:1115-1121.

Molau, U. 1993. Reproductive ecology of the three Nordic *Pinguicula* species (Lentibulariaceae). Nordic Journal of Botany 13: 149-157.

Müller, H. 1881. Alpenblumen, ihre Befruchtung durch Insekten und ihre Anpassung an dieselben. Wilhelm Engelmann, Leipzig.

Schnell, D.E. 2002. Carnivorous plants of the United States and Canada, 2nd edition. Timber Press, Portland.

Sitte, P., Ziegler, H., Ehrendorfer, F., and Bresinsky, A. 1999. Strasburger - Lehrbuch der Botanik für Hochschulen, 34th edition. Spektrum, Heidelberg.

Thien, L.B., and Marcks, B.G. 1972. The floral biology of *Arethusa bulbosa*, *Calopogon tuberosus* and *Pogonia ophioglossoides*. Canadian Journal of Botany 50: 2319-2325.

Wood, C.E., and Godfrey, J.K. 1957. *Pinguicula* (Lentibulariaceae) in the southeastern United States. Rhodora 59: 217-230.

An account of the *Nepenthes* species of Vietnam

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Introduction

It is the goal of this paper to provide an account of the *Nepenthes* taxa found in Vietnam and in particular to document the occurrence of *Nepenthes kampotiana* and update the conservation status of *Nepenthes thorelii*. In October 2015, the authors conducted a field trip to Vietnam to establish without doubt the number of taxa found in Vietnam. This paper will give an account of that field trip and also discuss the botanical history, ecology, taxonomy, and conservation status of *Nepenthes* in Vietnam.

In reviewing the current literature, it is apparent that there exists some confusion concerning the legitimacy and taxonomy of the *Nepenthes* of Indochina, and it is hoped this paper will help clear some of this confusion, at least for the taxa found in Vietnam.

For the purposes of this paper, the *Nepenthes* taxa found in Vietnam will be recognized as distinct in keeping with the taxonomy of Mey (2009) and McPherson (2009). This decision is supported by the recognizable morphology of each taxa in the field. It must be noted that there has yet to be a molecular-based study to support these conclusions.

Information about distribution, habitats, and morphological data, is based on examination of digitized images of herbarium specimens, observations of plants *in situ* and in cultivation, as well as extracted from literature (*i.e.*, all sources listed under "References"). Field work was conducted in Vietnam and in accordance with permits issued to visit Lo Go-Xa Mat National Park in Tay Ninh Province and Phuoc Buu National Park in Ba Ria-Vung Tau Province.

Discussion

1. Botanical history

There are currently three recognized *Nepenthes* found in Vietnam: *N. thorelii*, *N. mirabilis*, and *N. smilesii* have been officially recorded, and *N. kampotiana* is thought to have populations in Vietnam (McPherson 2009), although has never been officially recorded. The chronology of the Vietnamese *Nepenthes* species can be summed up as follows: *N. mirabilis* was the first species to be found and the type specimen for this species was collected in the old Cochinchina (now Vietnam) and described by Loureiro in 1790 under the name *Phyllamphora mirabilis*. The earliest publication of the correct binomial, *Nepenthes mirabilis*, was by Druce in 1916. In 1895 Hemsley described *N. smilesii* from Siam (Hemsley 1895). In 1908 Macfarlane described *N. anamensis* based on a Vietnamese type specimen (Macfarlane 1908). In 1909 Lecomte named three taxa: *N. geoffrayi* and *N. kampotiana* based on Cambodian material, and *N. thorelii* based on collections from Vietnam (Lecomte 1909). In 1928 Danser synonymized *N. smilesii* with *N. mirabilis* in his revision of the genus (Danser 1928).

Jebb and Cheek lectotypified the material of *N. thorelii*, and synonymized *N. kampotiana* and *N. geoffrayi* with *N. anamensis* and retained *N. smilesii* as a little known taxon (Jebb & Cheek 1997).

In 2009 McPherson reinstated *N. kampotiana* and synonymized *N. anamensis* with *N. smilesii*, following the interpretation provided to him by Cheek (pers. comm.), an interpretation that was previously supported by Mey (2009) and subsequently by Catalano (2010).

In recent years, the interest in cultivating *Nepenthes* has increased across Asia to include a number of Vietnamese enthusiasts. Co-author Chiem Nguyen Anh Vu has extended this interest in cultivation, to understanding and documenting the local *Nepenthes* species, with a key objective of preventing further habitat destruction and conserving populations from poaching. As part of this effort, in 2015 Chiem discovered populations of *N. kampotiana*, confirming McPherson's reported presence of this species in Vietnam.

2. Ecology

Nepenthes mirabilis (Fig. 1), *N. thorelii* (Fig. 2), *N. smilesii* (Fig. 3), and *N. kampotiana* (Fig. 4) share broadly similar habitats, in particular their preference for open, seasonally wet scrublands, where they grow amongst grasses. The wet season occurs from May to October, and the dry season lasts from late November to April. *N. mirabilis* is by far the most widely distributed of these four taxa and appears to be able to adapt to a wider range of habitats.

At its only known locality (Fig. 5), *Nepenthes thorelii* grows terrestrially on acidic, riverine silt at 10–20 m above sea level (Mey 2011). Plants occur singly or in small scattered groups across open and semi-open seasonal swamp land amongst *Melaleuca* scrub and grasses, occupying wet areas in full sun to part-shade.

The population of *N. smilesii* and *N. kampotiana* surveyed was located in a fairly dry environment, close to the coast, at or just above sea level (Fig. 6). The substrate in this open grassy scrub-

Figure 1: Upper pitcher of *Nepenthes mirabilis*, Binh Chau, southern Vietnam. Photo by Richard Nunn

Figure 2: Lower pitcher of *Nepenthes thorelii*, Lo Go-Xa Mat National Park, Vietnam – Cambodia border. Photo by Richard Nunn.

Figure 3: Lower pitcher of *Nepenthes smilesii*, Binh Chau, southern Vietnam. Photo by Richard Nunn.

Figure 4: Lower pitcher of *Nepenthes kampotiana*, Binh Chau, southern Vietnam. Photo by Richard Nunn.

Figure 5: The only known location of *Nepenthes thorelii* at Lo Go-Xa Mat National Park in Tay Ninh Province. Photo by Richard Nunn.

Figure 6: Typical habitat of *Nepenthes smilesii* and *N. kampotiana* at Phuoc Buu National Park in Ba Ria-Vung Tau Province. Photo by Richard Nunn.

land consisted of a much higher sand content than the *Nepenthes thorelii* site, not surprising given its proximity to the coast.

These three taxa are all clearly closely related and are superficially easy to confuse in the field. They do not generally form climbing stems, but rather a robust rosette with several growth points. Stems can be produced in the wet season, but these are desiccated during the dry season. Seasonal extremes have resulted in the need for adaptations to survive the arid conditions experienced during the dry season and the possibility of fire, with each of these taxa producing a lignotuber from which multiple growth points occur. Another interesting feature of these taxa is the production of rather long inflorescences, when compared to the stature of the rosettes, probably to keep the flowers above the surrounding grasses.

Nepenthes mirabilis is not part of the *N. thorelii* aggregate and has different growth characteristics, forming longer scrambling stems. This taxon was observed at two sites in Binh Chau (Fig. 7), growing in what appeared to be continually wet swamps in a coastal dune system. The substrate had a high sand content and *N. mirabilis* enjoyed the wetter parts of the swamp, with some plants found growing in shallow ponds.

The growth habit and ecological characteristics of *N. smilesii*, *N. kampotiana*, and *N. thorelii* have striking similarities to the *Nepenthes* species of northern Australia. Distinct wet and dry seasons are also prevalent in northern Australia and at least two of the taxa found there, *N. rowaniae* and *N. tenax*, also produce lignotubers to survive the harsh dry seasons.

Figure 7: A swamp in coastal dunes, near Binh Chau. This location hosts populations of *Nepenthes mirabilis*, *Drosera burmannii*, and at least four species of *Utricularia*. Photo by Richard Nunn.

3. Taxonomy

It is not the purpose of this paper to debate the taxonomic integrity of these four taxa, as both authors support the current accepted interpretation. The fieldwork conducted further strengthened our support of this concept, in particular the continued separation of *N. kampotiana* and *N. smilesii*. The key below outlines some of the morphological differences. However in the field, the three taxa in the *N. thorelii* aggregate, although superficially similar, are easy to identify by their pitcher morphology, which are distinct and immediately recognizable. Through the literature review and Internet searches, it appears that some images of *N. kampotiana* and *N. smilesii* have been incorrectly labeled and this has further added to the confusion.

Key to the Vietnamese *Nepenthes* species

1a. Leaves petiolate, margins of lower leaves fimbriate ..... *N. mirabilis*
1b. Leaves linear to lanceolate 2
2a. Short hairs on all vegetative parts 3
2b. Stem and leaves glabrous (pitcher and tendril excluded) ..... *N. kampotiana*
3a. Lower pitchers globose ..... *N. thorelii*
3b. Lower pitchers ovate to narrowly ovate ..... *N. smilesii*

The presence of large numbers of simple and complex hybrids made identifying the true parent species confusing at times and it took some time to understand what was really happening in the

Figure 8: Putative hybrid of *Nepenthes mirabilis* and *N. thorelii*, Lo Go-Xa Mat National Park, Vietnam – Cambodia border. Photo by Chiem Nguyen Anh Vu.

Figure 9: Putative hybrid of *Nepenthes smilesii* and *N. kampotiana*, Binh Chau, southern Vietnam. Photo by Richard Nunn.

swamp with the distribution of parent species and hybrids. This phenomenon was apparent at the *N. thorelii* site, where the number of hybrids with *N. mirabilis* (Fig. 8) outnumbered the parent species, at least in the area we surveyed, and also at the location for *N. kampotiana* and *N. smilesii* (Fig. 9). Again, superficial similarities exist with the swamps of Cape York in northern Australia, where the parent species seem to be in the minority and large simple and complex hybrid swarms form.

4. Distribution

The *Nepenthes* of Vietnam have not been conclusively studied and this paper is by no means a complete account of every location, as there is still much fieldwork to be done in this country. The map below is representative of the authors combined knowledge, and accounts in literature, of *Nepenthes* sites that are still viable.

5. Conservation status

Vietnam is no different from any developing economy in the Asian region, and habitat destruction through logging, agriculture, and property and infrastructure development is a major threat to its biodiversity. Southern Vietnam, where Vietnam's *Nepenthes* are concentrated, has also been subject to war and the extensive use of defoliants, which destroyed large areas of natural vegetation. Poaching is also increasingly an issue in the region, fueled by a growing local interest in *Nepenthes* and unscrupulous western markets for wild collected plants.

South Central Coast
Vietnam
Central Highlands
Southeastern
Mekong River Delta
Quang Tri
Thua Thien-Hue
Da Nang
Quang Nam
Quang Ngai
Kontum
Binh Dinh
Gia Lai
Phu Yen
Daklak
Khanh Hoa
Dak Nong
Binh Phuoc
Lam Dong
Ninh Thuan
Tay Ninh
Binh Duong
Dong Nai
Ho Chi Minh
Dong Thap
Long An
An Giang
Tien Giang
Ben Tre
Can Tho
Vinh Long
Kien Giang
Hau Giang
Tra Vinh
Soc Trang
Bac Lieu
Ca Mau
N. smilesii
N. smilesii and mirabilis
N. smilesii and mirabilis
N. thorelii and mirabilis
N. smilesii, mirabilis and kampotiana

Fieldwork conducted for this paper and discussions with local *Nepenthes* experts suggests that *N. mirabilis*, *N. kampotiana*, and *N. smilesii* are widespread and not under serious threat in Vietnam, many populations occur in well-managed National Parks or areas that are unlikely to be developed. *Nepenthes thorelii* is endemic to Vietnam and extant at only a single, small site of less than 1 km^2 located in Lo Go-Xa Mat National Park, Tay Ninh Province, Vietnam – adjacent to the type locality (Mey 2010). This population appears to be healthy and well protected from poachers by Park Rangers and entering this site is no easy process, with expensive permits required and passing through two park check points and a military check point.

Conclusions

Three conclusions can be drawn as a result of the fieldwork and literature review on the *Nepenthes* of Vietnam:

1. There are four distinct species of *Nepenthes* in Vietnam, and *N. kampotiana* is present as predicted by Mey (2009) and McPherson (2009). Our fieldwork, although limited to a small number of locations, supported the current taxonomic treatment, and the four taxa present exhibited strong and stable morphological differences.
2. In a phenomenon that is also seen in the swamps of northern Australia, hybrid swarms are present and this makes identification of the true species difficult. Northern Australia and southern Vietnam are both at the extreme ends of the range for *Nepenthes* and they have similar and distinct wet and dry seasons and the genus has developed similar survival strategies to deal with the latter.
3. The only known population of *N. thorelii* at Lo Go-Xa Mat National Park is healthy and well protected from poachers and habitat destruction. Park rangers are aware of the plants and their importance, and they are making an effort to ensure the site is well managed and infrequently visited.

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References

Catalano, M. 2010. *Nepenthes* della Thailandia - Diario di viaggio. http://www.piantecarnivore.net/libroth.html

Danser, B.H. 1928. The Nepenthaceae of the Netherlands Indies. Bull. Jard. Bot. Buitenz. Ser. 3, 9 (3-4): 249-438. Reprinted 2006 with an Introduction by Dr. Charles Clarke by Natural History Publications (Borneo), Kota Kinabalu.

Hemsley, W.B. 1895. *Nepenthes smilesii* (Nepenthaceae). Royal Botanic Garden, Kew; Bulletin of Miscellaneous Information, 1895: 116.

Jebb, M.H.P., and Cheek, M. 1997. A skeletal revision of *Nepenthes* (Nepenthaceae). Blumea 42: 1-106.

Jebb, M.H.P., and Cheek, M. 2001. Nepenthaceae. Flora Malesiana, Series I, Volume 15: 1-157.

Lecomte, P.H. 1909. Les *Nepenthes* d'Indo-Chine. Notulae Systematicae: 46-65.

Kurata, S. 1976. *Nepenthes* of Mount Kinabalu. Sabah National Parks Publications No. 2, Sabah National Parks Trustees, Kota Kinabalu.

Macfarlane, J.M. 1908. Nepenthaceae. In: A. Engler, Das Pflanzenreich: 39-40.

McPherson, S.R. 2009. Pitcher Plants of the Old World. Poole, England: Redfern Natural History Productions.

McPherson, S.R. 2009. *Nepenthes* of Peninsular Malaysia and Indochina. In: McPherson, S.R. Pitcher Plants of the Old World. Poole, England: Redfern Natural History Productions: 549-631.

Mey, F.S. 2009. *Nepenthes bokorensis*, a new species of Nepenthaceae from Cambodia. Carniflora Australis. Journal of the Australasian Carnivorous Plants Society Inc. 7(1): 6-15.

Mey, F.S. 2010. The elusive *Nepenthes thorelii*. In: McPherson, S.R. Carnivorous Plants and their Habitats. Volume 2. Poole, England: Redfern Natural History Productions: 1340-1367.

Mey, F.S., Truong, L.H., Dai, D.V., and Robinson, A.S. 2011. *Nepenthes thorelii*, an emended description and novel ecological data resulting from its rediscovery in Tay Ninh, Vietnam. In: McPherson, S.R. New Nepenthes: Volume One. Poole, England: Redfern Natural History Productions: 104-131.

Mey, F.S., Catalano, M., Clarke, C., Robinson, A., Fleischmann, A., and McPherson, S. 2010. *Nepenthes holdenii* (Nepenthaceae), a new species of pyrophytic pitcher plant from the Cardamom Mountains of Cambodia. In: McPherson, S.R. Carnivorous Plants and their Habitats. Poole, England: Redfern Natural History Productions. (Appendix).

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Drosera pauciflora – the queen of the sundews

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Drosera pauciflora Banks ex DC is a flat-rosetted sundew endemic to the Western Cape of South Africa which produces flowers up to 6 cm diameter that are the largest in the genus (Obermeyer 1970). These magnificent flowers make *Drosera pauciflora* an apt queenly partner to the king sundew, *Drosera regia*. *Drosera pauciflora* is perhaps better known from plants in cultivation than in the wild, to help rectify this I present information from field and herbarium studies to give this species more context.

Drosera pauciflora (Fig. 1) has been described by Obermeyer (1970: p. 196) to which I add the following details: The lower surface of the leaf have three to five raised longitudinal veins that are most conspicuous in the basal half of the leaf. Two small filiform stipules to 3 mm long are present on either side of the lowermost edge of the leaf. Plants can produce a second scape in spring under favorable conditions that extend the growing season, and flowers have either white or pink – purple petals. Each style segment is bifurcated near its apex into the stigma which comprises a fan-shaped array of about 20 filiform to narrowly obcuneate segments (Fig. 1(a, b)). In cultivation the flowers do not set seed when self-pollinated but will set seed when crossed with other clones of *D. pauciflora*, or even some forms of the closely-related *D. cistiflora*. Mature seeds are small, dark grey, ovoid to ellipsoid to about 0.5 mm long by 0.2 mm maximum diameter, lacking a funicle, with an obtuse apex, and with a foveolate testa (Fig. 1(c)).

The conspicuously tall scapes of *D. pauciflora* appear to have developed, at least in part, to ensure that flowers are held above the surrounding herbage. This results in flowers that are visible and readily accessible to potential pollinators (Anderson 2010).

Distribution

Drosera pauciflora occurs in the South West Cape, where it primarily occurs on the coastal plain on the eastern outskirts of Cape Town (the 'Swart land'), with most records between Cape Town, Stellenbosch, Malmesbury, and Darling (Rivadavia 2000; The Open University 2016). It also grows in the Tulbagh basin to its east, between Wolseley and Tulbagh. There are also collections from some adjoining sandstone ranges on Table Mountain Sandstone at locations to about 1000 m elevation. Strangely there is also a disjunct population near Garies in the Kamiesberg, about 400 km north of Cape Town where plants occur at about 1000 m elevation in herbfields naturally irrigated by rain falling on adjacent granite outcrops (Fig. 2).

Variation

Drosera pauciflora plants typically have pink-petalled flowers across their range. However, white-petalled plants occur primarily in the southern part of its range particularly between Paarl, Tygerberg, Stellenbosch, and the adjacent Jonkershoek valley. Around Darling are plants that readily produce daughter plants and form large clonal colonies over 1 m across (Fig. 1(d)). Plants with pink petals with yellow markings near their otherwise black bases have been collected around Wolseley,

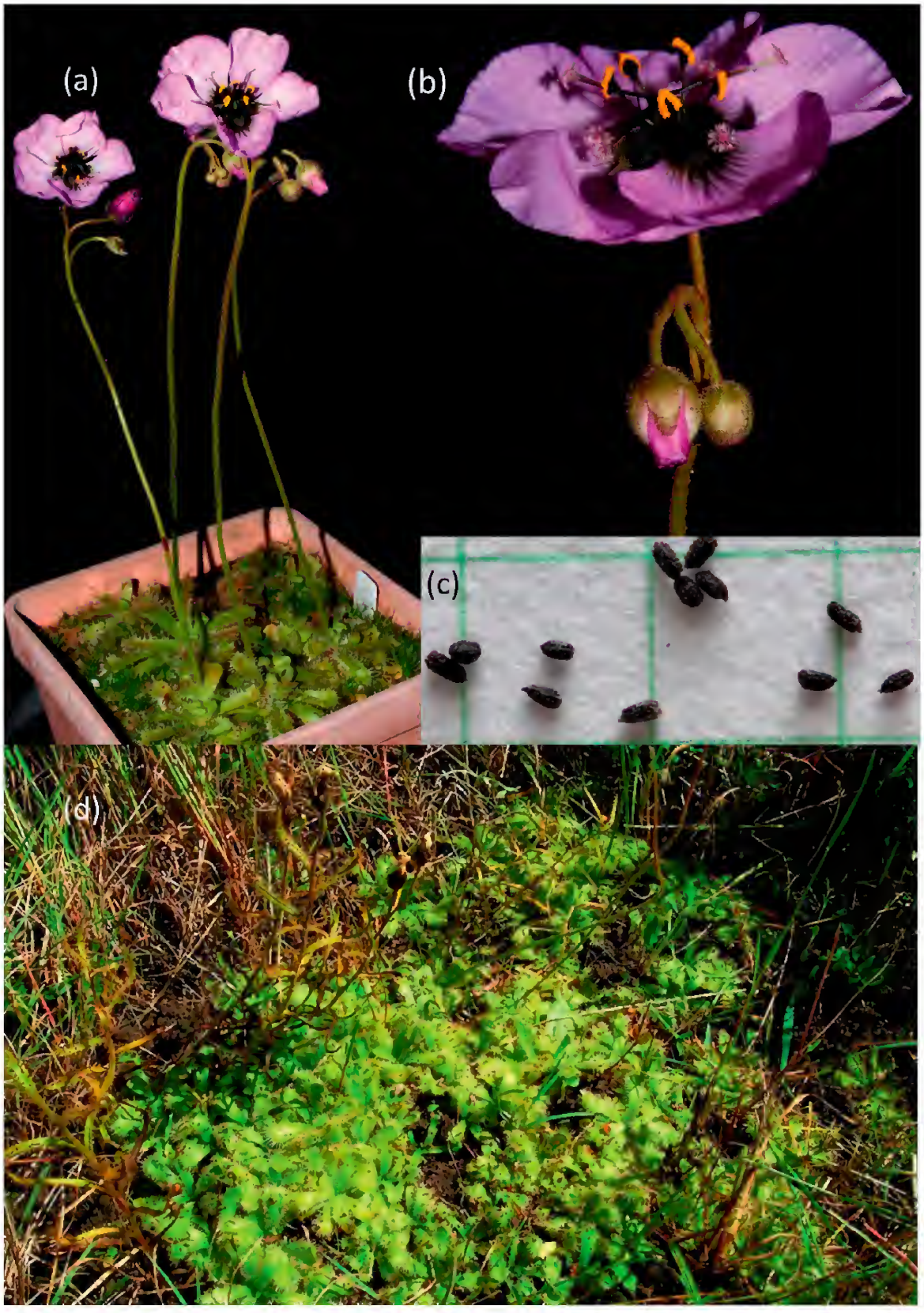

Figure 1: Photomosaic of *Drosera pauciflora*: (a) Plants in flower in cultivation; (b) Buds and open flower of *D. pauciflora*. Note the abundant stigmas at the ends of each style segment; (c) Ripe seeds on a 2 mm grid; and (d) Clonal colony of *D. pauciflora* near Darling (growing with *D. cistiflora*).

and have been described as a separate species, *D. atrostyla* P.Debbert (Debbert 1991). Plants from the Kamiesberg have rosettes to 5 cm across and flowers to 2 cm diameter, and are thus smaller than the typical form of this species (Bean & Viviers 25759, NBG). These variants require further study.

Small rosetted plants in the South West Cape with narrow leaves and with commensurately smaller scapes and flowers have previously been treated as *D. pauciflora* var. *minor*. However they lack stipules, may develop a few cauline leaves, and only have short obovoid insect-trapping glands on the leaves and thus have more affinity with *D. cistiflora* L. Such plants have been described as distinct species: *D. zeyheri* T.M.Salter (Salter 1940) and *D. coccipetala* P.Debbert (Debbert 2002). The taxonomic status of these two taxa are controversial and are considered to be within the large and variable *D. cistiflora* (Obermeyer 1970; Brittnacher 2014).

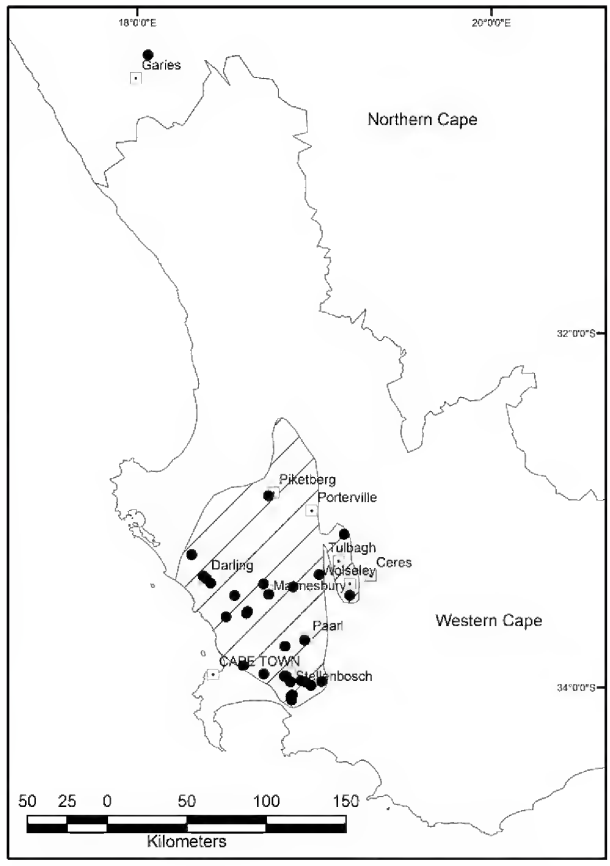

Figure 2: Distribution map based on published descriptions, herbarium study and field study. Black circles denote collections or observations. The approximate range of *D. pauciflora* is shown by diagonal hatching. Note the disjunct population near Garies in the Northern Cape.

Cultivation

In Newcastle, New South Wales, *Drosera pauciflora* is grown best in large, full length black plastic pots about 20 cm diameter in a mix of about equal parts peat moss and medium-grained sand. During the summer when plants are dormant, the pots are stored outside in a shelf. The shelf is protected from the rain and direct sunlight by the house. They are stacked with pots containing tuberous *Drosera* and watered lightly every month or so to ensure that the mix does not completely dry out. When new growth emerges between February and April the pots are placed on a shelf on the northern side of the house which receives several hours of full sun each day. Minimum temperatures at this time of year are typically about 15-20°C, with maximum temperatures around 25-35°C. Plastic saucers are placed under the pots that contain up to 1 cm of water so that the mix is damp rather than wet.

After emergence the rosettes grow quickly and develop full-sized rosettes within about 6 weeks. Growth slows during winter when temperatures range from 2-15°C and 13-25°C. The plants are voracious feeders and appear to benefit from regular feeding of either live insects, such as flies or mosquitoes, or monthly spraying with an organic orchid fertilizer, such as fish emulsion at about half the recommended strength. Between July and September the larger rosettes start to form scapes which grow to flowering in about 4 weeks. Fruit-set from is a relatively slow process, with dehiscence of ripe seed taking about 4 weeks from pollination. Plants enter dormancy between October and December when the pots are once again stored away.

Propagation

Drosera pauciflora may be propagated by seed, natural division or leaf cuttings. Seed is periodically available from commercial sources. It is best sown in autumn when soil temperatures are cooling, but I have found germination rates to often be low. Seedlings grow slowly and must have formed a sufficiently large root by the end of their first spring in order to survive their first summer. During the summer dormancy the soil mix around seedlings must not completely dry out, and thus desiccate the root, and also must not be too moist, when the root may rot. Thus seeds and seedlings present several challenges. Seedling survival may be increased by germinating seeds indoors under artificial lights, applying a regular dose of dilute fertilizer to increase growth rates, and careful repotting into fresh media (R. Maharajh, pers. comm., March 2016).

Mature plants naturally produce secondary plants from the root systems, especially from plants near the town of Darling. These daughter plants grow quickly and can reach flowering size in their second year when they have developed independent root systems. Clonal groups of plants can be split every few years.

Leaf cuttings work very well, and are best taken in autumn or winter when the resulting plantlets have a better chance of surviving their first summer dormancy. One or two leaves may be removed at a time from a mature rosette. I place detached leaves on a ca. 1 cm deep layer of moist mix of peat and sand in a clear rectangular plastic container, the sort used for take-away food. The lid is loosely attached and the container is set at the base of an east-facing window that receives bright light but very little direct sunlight in the winter months. Leaves are set on the mix, glandular-hairy side up with their base shallowly buried in the mix. Over the next 6 weeks most leaves remain green and a small swelling forms near the apex of the leaf (Fig. 3) – some leaves also produce a small swelling near their base. These swellings develop into new rosettes. A single root usually develops from the base of the developing rosette, and as the parent leaf dies away the new plant can be potted up. In some cases root development is triggered only after transferring plantlets onto a mix of moist sphagnum moss. Once they have developed a root system, they can be potted up the same way as parent plants.

Leaf cuttings taken in spring commonly die, even those with forming plantlets, seemingly due to increasing ambient air temperatures. Leaf cuttings can be taken two or three times a season from mature rosettes and thus offer a way of rapidly multiplying.

From my experience with this species it is best to start with established plants. They are readily propagated by leaf cuttings and division of clonal clumps.

Figure 3: Detached leaf producing a lump near its apex which will develop into a new plant.

Conclusions

Drosera pauciflora is a beautiful species in leaf and unforgettable when seen in flower. This sundew requires basic conditions of summer dormancy to be met. If you successfully grow a number of different tuberous *Drosera* taxa then this species is definitely worth trying. For best success start with an established plant.

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References

Anderson, B. 2010. Did *Drosera* evolve long scapes to stop their pollinators being eaten? Annals of Botany 106: 653-657.

Brittnacher, J. 2014. Carnivorous Plant Names Database. Updated 15 October 2014. http://www.carnivorousplants.org/cpdb/SearchCPdb.php (viewed 8 March 2016).

Debbert, P. 1991. Einige neue Arten der Gattungen *Drosera* (Droseraceae) und *Pinguicula* (Lentibulariaceae). Mitt. Bot. Staatssammlung München 30: 373-380.

Debbert, P. 2002. Einige neue *Drosera*-Arten aus Südafrika (Droseraceae). Linzer biol. Beitr. 34: 793-800.

Obermeyer, A.A. 1970. Droseraceae. In L.E. Codd, B. de Winter, D.J.B. Killick, and H.B. Rycroft (Eds.). Flora of Southern Africa 13. Pretoria. pp. 187- 201.

Rivadavia, F. 2000. Endless carnivorous plants in Cape Town, South Africa. Carnivorous Plant Newsletter 29: 42-45

Salter, T.M. 1940. Plantae novae Africanae Series XV. The Journal of South African Botany 6: 165-175.

The Open University. 2016. iSpot Share Nature. Species Dictionary. Southern African National Biodiversity Institute. http://www.ispotnature.org/species-dictionaries/sanbi (viewed 30 January 2016).

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Deep in the web, up in the hills: the discovery of *Drosera magnifica*, the "Facebook sundew"

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Social media are part of the daily life in the modern society: we follow the news on Twitter, share funny gifs on Tumblr, post selfies on Facebook, spread scientific papers on ResearchGate, and share experiences and trade plants in the discussion forums. Among all possible connections achieved by the social media, one that has always captivated me is the bridge they created to connect professional biologists to "citizen scientists". From the age of the forums to Facebook, I've been following with keen interest posts with photos of carnivorous plants in their natural habitats in Brazil and abroad, and many new regional records were found that way, and even species discoveries and re-discoveries.

The long-lost *Drosera ascendens* A.St.-Hil. was rediscovered thanks to social media, as it was the discovery of the peculiar *D. chimaera* Gonella & Rivadavia. Both findings were made possible thanks to photos posted by the carnivorous plant enthusiast Adilson Peres in the Brazilian carnivorous plant forum back in 2010. His photos and the information he provided on the location of his encounters enabled us to collect and study these plants, and finally solve the taxonomy of the group (see Gonella *et al.* 2014). Cases of discoveries of new species thanks to social media are not restricted to carnivorous plants, though. The enormous palm *Tahina spectabilis* J.Dransf. & Rakotoarinivo from Madagascar was also discovered through photos posted on an online palm discussion forum (Dransfield *et al.* 2008). And new species of the parasitic *Amyema* (Loranthaceae) and *Rafflesia* (Rafflesiaceae), were discovered thanks to photos posted in the online image database "Co's Digital Flora of the Philippines", and in the Facebook discussion group of the said project, respectively (Pelser & Barcelona 2013; Barcelona *et al.* 2014).

The discovery of the "magnificent sundew" starts in a somewhat similar way, in an ordinary day in early September 2013. I was scrolling down my Facebook feed when I came across this post by a friend of mine who was sharing a photograph of a large clump of *Drosera* in its habitat, inquiring for its identification. The photo was originally taken and posted by Reginaldo Vasconcelos, a plant enthusiast and skilled orchid grower from Governador Valadares, eastern Minas Gerais state, Southeast Brazil.

The long and broad, seemingly sessile leaves, and the long scapes with multiple flowers of the plants in the photograph immediately caught my attention, and I started to wonder where those plants were found. At a first glance, the plants were a little reminiscent of the South African *Drosera regia* Stephens, but they were certainly not any South American *Drosera* known so far. My first reaction was to call Fernando Rivadavia's attention to that picture. Fernando is a well-known carnivorous plant specialist; he discovered many new species during more than 2 decades exploring the most remote areas of Brazil, many of those species we published together in the last 5 years. He got really excited and curious with the picture as well, so we decided to contact Reginaldo, the photographer, to get more information about where and when those plants were found.

Reginaldo kindly provided all information necessary plus a few more pictures, which got us even more excited. For our surprise, those pictures were taken at the top of a mountain in a remote area that neither of us had ever been before, as we would never expect to find something new there. In fact, we later learned that practically no botanist had ever been there before us. With all information we needed gathered, thanks to Reginaldo, we immediately started planning a trip to the area

so we could properly study this potential new species. Less than 3 months after first seeing the pictures, there we were, climbing the mountain (Fig. 1).

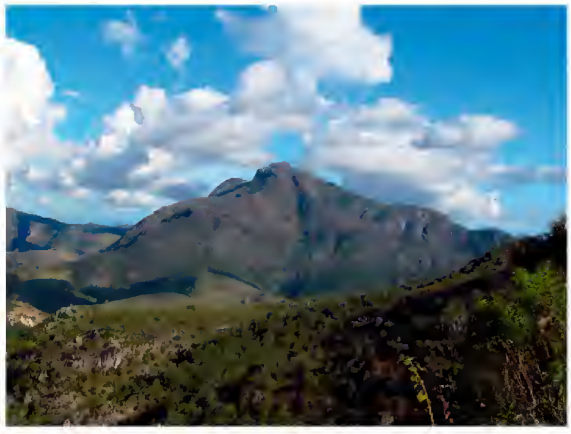

Figure 1: The mountain where *Drosera magnifica* grows, in Southeast Brazil.

It was late November 2013 when we got to this little town in eastern Minas Gerais, called Conselheiro Pena. It was mid rainy season, so the sky was quite cloudy and drizzling, and the dirt roads were specially muddy and slippery from the heavy rains in the previous days. Although it delayed us for some hours, the slippery road didn't stopped us to reach the mountain base, even though we had to leave our car behind after we reached a huge slippery slope, and walk for a few kilometers under rain. Finally, we reached the mountain base and met Ednilson and his family. Ednilson is a local resident that guided us to the mountain peak, where the plants were photographed by Reginaldo.

After four hours of hiking and climbing the mountain under light rain and strong cold winds, we finally reached the mountaintop, at an elevation of 1500 meters. It was a nice view: small shrubs covered with lichens, orchids, and bromeliads among rocks, and large tree-like *Vellozia* plants, with beautiful lily-like purple flowers. Inside the water tank formed by the leaf bases of large bromeliads we found *Utricularia nelumbifolia* Gardner (Fig. 2), with deep violet, large orchid-like flowers. Growing in a humid hill with dripping water, over mosses, we also found pale lilac-flowered *U. nephrophylla* Benj. and a beautiful dwarf form of *U. reniformis* A.St.Hil. (Fig. 3). But the best was still to come.

Júlio César, Ednilson's son that was also accompanying us in the mountain trip, pointed, excited, to some reddish bushes in the distance – "there it is!" We couldn't believe our eyes… Those plants were huge! We were clearly in front of one of the greatest botanical discoveries of the decade. We got close to the plants and many more started to appear. They were growing by hundreds in this very narrow habitat in the hillside (Fig. 4). And, for our surprise, they had really long stems, usually sprawling all around, but also erect, supported by the surrounding vegetation.

Figure 2: A Large bromeliad (*Vriesea sanctaparecidae*) hosting *Utricularia nelumbifolia* (left) and flower of *U. nelumbifolia* (right).

We started taking pictures and measurements, as it was already quite late in the afternoon. We also collected some plants for herbarium studies, so we could properly describe it for science and compare to previously known species. Unfortunately, it was too soon for seeds, which were all still unripe, but we could get enough material for the botanical description.

Figure 3: *Utricularia nephrophylla* (lower left) and dwarf form of *Utricularia reniformis*.

The size of this new species is impressive. The numerous leaves that can be up to 18 active leaves in a single rosette can reach up to 24 cm long. They lack an obvious petiole, as the tentacles start to appear from the very base and cover the entire upper leaf surface, except for a small triangular-shaped area at the very base, which is covered by simple hairs. The stipules are large, triangular-shaped, and golden colored (Fig. 5). The inflorescences can reach up to 35 cm long and present a very characteristic candelabra shape, with many branches in the upper part that can bear as many as 190 flowers, each 2 cm in diameter with light pink petals (Fig. 6 and Back Cover). But, the most impressive part of the plants is the stem, which is densely covered by dead leaves and can reach up to 123.5 cm long. In total, including stem, leaves, and flower scape, the largest plant seen was more than 150 cm long! The stem is usually prostrated on the ground, but often ascending on the apex, using the surrounding vegetation as support and reaching up to 30–40 cm above the ground level. We found a few plants with bifurcated stems, and many plants with small plantlets

Figure 4: The gigantic *Drosera magnifica* forming a large clump among grasses and bushes.

Figure 5: *Drosera magnifica*, with its characteristic sessile leaves, golden stupules and circinate-involute leaf vernation.

emerging from the stem base, and a few also from the roots. Although it produces numerous flowers and copious seeds per fruit, we saw no seedling in the area, which made us believe that asexual reproduction may be the main reproduction strategy of this new species. The way the immature leaves are folded is very unique among the South American *Drosera* as well: it is coiled along its length, but also has the margins folded inwards, in a fashion similar to that of the unrelated South African *D. regia* and the Australian *D. adelae* F.Muell., both with similarly shaped leaves. This new species is by far the largest *Drosera* in the American continent and one of the three largest of the world, together with *D. regia* and the tuberous *D. gigantea* Lindl., the latter from Australia. With such unique and majestic appearance, we decided to call it *Drosera magnifica* Rivadavia & Gonella, a name that requires no explanation.

Although it presents very unique features, *D. magnifica* is clearly closely related

Figure 6: *Drosera magnifica* in habitat. Notice the single candelabra-shaped inflorescence per plant, with multiple flowers (left) and flower covered by rain drops (right).

Figure 7: *Drosera tomentosa* var. *tomentosa* (left) and *Genlisea violacea* (right) found on one of the nearby peaks.

to the two long-leaved Brazilian species: *D. graminifolia* A.St.Hil. and *D. spiralis* A.St.-Hil., both of which grow more than 200 km apart, in the Espinhaço Range (Gonella *et al.* 2012). The habitat preferences of *D. magnifica* are very similar to those of *D. graminifolia*: both species grow in high-altitude rock outcrops, with high humidity throughout the year and cooler temperatures, but also with lots of direct sunlight. Such habitat preferences make the cultivation of *D. magnifica* quite tricky, as one would have to imitate such conditions to grow it well.

Seven months after the first visit to the area, we planned another trip, in July 2014, to collect more information about the species, but also to search for it in other mountains of the region. This time we had Reginaldo, the discoverer, with us, and also Carlos Rohrbacher, skilled carnivorous plant grower. We climbed two nearby peaks of similar elevation hoping to find more *D. magnifica* populations, but couldn't locate any, unfortunately. However, we did find *Genlisea violacea* A.St.-Hil. and *Drosera tomentosa* A.St.-Hil. var. *tomentosa* growing together in a small seepage in one of the peaks (Fig. 7). These other peaks were too dry compared to the one where *D. magnifica* grows, which reinforces that it requires very specific growing conditions. It seems to be very endemic to this singular mountaintop, where it is quite abundant, but severely threatened with extinction by invasive grasses that compete for light and space, and habitat destruction for coffee and eucalyptus plantations. For that reason, this newly discovered species is already considered Critically Endangered, the most severe category of threat, following the IUCN Red List categories and criteria, an international organization for the conservation of biodiversity.

It is astonishing that such a large and conspicuous plant species remained undiscovered until now in a country that has been historically very well botanized. This is an example of how little is still known about the Brazilian biodiversity, the largest in the world, and raises the question: what else is still out there, waiting to be discovered?

References

Barcelona, J.F., Manting, M.M.E., Arbolonio, R.B., Caballero, R.B., and Pelser, P.B. 2014. *Rafflesia mixta* (Rafflesiaceae), a new species from Surigao del Norte, Mindanao, Philippines. Phytotaxa 174(5): 272-278.

Dransfield, J., Leroy, B., Metz, X., and Rakotoarinivo, M. 2008. *Tahina* – a new palm genus from Madagascar. Palms 52(1): 31-39.

Gonella, P.M., Rivadavia, F., and Sano, P.T. 2012. Re-establishment of *Drosera spiralis* (Droseraceae), and a new circumscription of *D. graminifolia*. Phytotaxa 75(1): 43-57.

Gonella, P.M., Rivadavia, F., and Fleischmann, A. 2015. *Drosera magnifica* (Droseraceae): the largest New World sundew, discovered on Facebook. Phytotaxa 220(3): 257-267.

Pelser, P.B., and Barcelona, J.F. 2013. Discovery through photography: *Amyema nickrentii*, a new species of Loranthaceae from Aurora Province, Philippines. Phytotaxa 125(1): 47-52.

A tribute to David Crump (1953-2016)

Larry Mellichamp • retired botanist

Some of you knew David Crump of Charlotte, North Carolina who ran a company called Carolina Carnivores. He specialized in *Sarracenia* and *Dionaea*. He passed away suddenly on May 13 after a long illness.

Dave got interested in CP about 1990 when he visited the University of North Carolina at Charlotte Botanical Gardens while I was in the midst of hybridizing Sarracenias. I gave him hundreds of my "cast-off" seedlings from my breeding program and he constructed in-ground bog beds and grew them on to perfection to sell and trade. Several of those random seedlings turned out to be good plants which he recently had tissue-cultured, such as *Sarracenia* 'Carolina Yellow Jacket' and *Sarracenia* 'Bug Bats'. *Sarracenia rosea* 'Fat Chance' was from a wild-collection from Perdido, Alabama in 1985. Many other interesting hybrids were in the "experimental observation stages." Dave was very talkative, and always had questions about CP. He devised ideas on how they evolved and how they functioned. We talked for many hours. He was interested in educating people on CP. Enjoying his plants and watching him construct bog gardens provided inspiration for the unique chapter on bog plants in my 2014 book Native Plants of the Southeast. One day we sat for hours watching his array of healthy Venus flytraps snapping up flies attracted by smelly left-over fish-bait minnows laid out in the bed (See CPN, 1999 Vol. 28. No. 3, p. 96). He sold plants by mail and at the local farmers' market, and did presentation for groups in the area. He had hundreds of plants in his back yard in pots and beds. He always had an idea for a new hybrid or a new way to market. He loved his plants and the joy they brought. Dave will be missed.

Book review

Kaelin, Matthew M. 2016. The Sinister Beauty of Carnivorous Plants. Hardcover: 144 pages, Dimensions: 9.3 × 0.7 × 12.2 inches. Schiffer (May 28, 2016). ISBN-13: 978-0764350986.

Reviewed by: Richard Nunn • richard@carnivorousplants.org

Matthew M. Kaelin is an artist and natural history enthusiast who is deeply influenced by his immediate surrounds, his carefully tended carnivorous plant collection, and the natural habitats of his native Long Island. This work is the synthesis of his art and his environment and is the culmination of many years of perfecting the medium of macro and portrait photography to capture his subject, the carnivorous plants.

At first glance, this might appear to be simply a coffee table art-book. Although by reading further, it will be found to have greater depth than normally seen in such works. In botanical photography books, the photographer rarely ever cultivates their own plants, nor do they often contribute meaningful efforts to conservation. They tend to simply be a collection of pleasant images of a botanical theme. This book on the other hand, has personal involvement, specific information for reference, and there is a darker, more intense artistic vitality than is usually seen in such works.

Conducting this review as one would normally with a scientific or horticultural treatment of carnivorous plants would be an injustice to what is essentially an art-science fusion book and hence the review will focus on the artistic merit of the work. This volume is essentially split into three sections, and this review will deal with each in turn.

First, 84 pages of lavishly produced color plates, portray the most intimate details of these plants. Each work has a title captured in post-modern/conceptual art language, for this language can be powerful and beautiful. Kaelin uses this language in order to clarify the emotion the artworks are meant to convey, and to communicate to the viewer in an elegant and direct manner. Visually, the work is influenced by the dark art of Swiss surrealist artist, H.R. Giger. The author is attempting to create an immersion into this world through compositions which inspire the emotions of intensity, fear, and lascivious seduction, which are perhaps the very reasons that many of us are drawn to the subject of carnivorous plants.

The reader is then seamlessly moved into the realms of cultivating the subjects so painstakingly captured in Kaelin's art. This is not a comprehensive cultivation guide nor is it meant to be, but more an outline of the struggle to achieve perfection in artificial environments. The culmination of this section is a roster of the beautifully cultivated plants that form the basis for the artworks, again captured to perfection in stunning studio images.

The third section is a native habitats chapter and is where the most entertaining and enlightening writing will be found. Kaelin has been influenced by Edgar Allan Poe, and this might very well be apparent in the text. It is a natural-history narrative in the vein of the Romantic period of naturalist writing, but more specific in scope, and being a bit heavier in feel. Overall, the visual and conceptual elements are meant to move the story of the book, and then divert the viewer's attention to information as a vehicle for learning about the subjects themselves. This information covers the plants scientific names, cultivar histories, natural habitats, and very importantly, their conservation status, since so many are in danger of extinction in the wild. This brings greater depth and meaning to the artistic project, and provides the opportunity for exploring education and conservation in the spirit of a natural history collection.

For those looking for another book on cultivation or a general overview of the carnivorous plants, this may not be the first choice for you. These are topics that have been covered extensively and little more can be added that will make a meaningful difference to our store of knowledge. In this book, we have a completely fresh and unique perspective on these amazing plants, and one that is worthy of a place in anyone's carnivorous plant, natural history, or art library.

Book review

Hewitt-Cooper, Nigel. 2016. Carnivorous Plants: Gardening with Extraordinary Botanicals. Hardcover: 232 pages, Dimensions: 8.1 × 0.8 × 9.1 inches. Timber Press (February 24, 2016). ISBN-13: 978-1604695793.

Reviewed by: Marcel van den Broek • marcel@carnivorousplants.org

In front of me lies a new book on carnivorous plants. It is one of several books that has been published recently and, as it is a general book, I'm intrigued to find out what it has to offer compared to other publications.

Early in the book, the author states: "It seems there remains a gap in the market, however—a lack of information in print as to the general cultivation of carnivorous plants. I still hear this from people, as well as the problem that the huge amount of information available online is bewildering and often contradictory. The purpose of this book is to act as both a general introduction to the genre of carnivorous plants, and as a guide for the more advanced grower who may have had a few successes and wishes to delve deeper into this peculiar and somewhat alien world."

I'm afraid I have to disagree with the first part of that statement, even before getting to the content.

First of all it doesn't do justice to some excellent general works by others, like the books by Barry Rice, Natch Greyes, and of course Peter D'Amato. Secondly it underestimates the Internet skills by the younger generation. There is plenty of good information on the web and in my experience they are quite capable of finding it. Having said that, we have a book that aims to be a general introduction for people who are just starting and the more advanced grower that wants to improve. I therefore have read the book through those eyes.

The book opens with a fairly standard story on the relation between science and carnivorous plants with the household names you would expect. Darwin, Governor Dobbs, and Veitch all come by in a good and to the point text. Then the author goes into definitions, opening with citing what criteria make a carnivorous plant. As there are more definitions around and the debate on which one to use will probably last us for some time to come, I will only say that the approach selected is a narrower one, and indeed, *Roridula*, *Byblis*, and the Bromeliads don't get mentioned in the book. The author continues by giving definitions on subjects like cultivars and forms and needs to be commended for being one of the few authors that will go there. He continues this with explanations on flowers that are monoecious, dioecious, and subjects like self-fertile as opposed to self-pollenating and self-sterile. Again a very good point for an introduction as many new growers are not familiar with these terms.

Further along the author goes into what he calls the "three golden rules" for temperate species. Essentially keep the plant in full sun, keep it wet with rain water, and give it a cold dormancy. At this point I get a bit confused. After giving three golden rules for temperate species, I would have expected rules for tropical species, possibly a bit split up to make distinctions in preferences of several plants. However, these are not mentioned.

The confusion continues as artificial lighting is worked out in case full sun is not available. In my experience, most temperate species don't do well in amateur set ups with artificial light so perhaps not the best place for this text. A number of possible light sources are mentioned, but while the book has some nice clear tables, a much in demand table is missing about how much light a species needs and what light to use.

In the water section, the author does a good job explaining things about water, including the boiling myth and temporary and permanent hardness of water. Personally, I haven't encountered that distinction often, but it is very clear.

As I mentioned, the book has some very clear tables and we encounter a nice table showing temperature during dormancy. However, there is a part that will likely confuse the novice grower. For example, terms like South African *Drosera* and terrestrial *Utricularia* are used, but these plants will not be discussed until much later in the book. Also it is a pity that the ever popular Venus flytrap doesn't appear in the table, but does get mentioned in the text.

The part of the book that deals with what soil mix to use is good and has some clear pictures of various products. Again a clear table, but it does use terms like pygmy *Drosera* and terrestrial *Utricularia* that still need to be explained to our novice.

The where to grow section is also nice, combining general information with details like the height of a bench in a greenhouse. The section on bogs is illustrated with bogs in various parts of the world. Even the use of carnivorous plants at pond margins is discussed, with the warning that fish will produce too much nutrients for the plants.

The text on planting terrariums is also very good and contains much of the information a first-time builder would want. The section on year-round maintenance and tools could have been a bit longer, but deals with the basics.

This is followed by a section on pests and disease that is both thorough and has some clear pictures. Frankly, this is the best such section in a beginner's book that I personally have seen so far.

A small negative point is that some of the pesticides mentioned are not available to the general public (at least not in several countries) and that is actually a good thing in my opinion. For instance, the first product mentioned, Acetamiprid, is a neonicotinoid that is extremely harmful to bees. More friendly alternatives are mentioned, though not by name. I'm afraid that the average starting grower is likely to pick the first product mentioned if he can get it, so maybe not such a good idea.

By now we have read almost half the book (86 pages) and we are getting to the plants.

The first section deals with what is called "Common carnivores for easy growing". Geography, habitat conditions, cultivation, and propagation are discussed in clear texts. It is only in this section that the reader learns a bit more about terms like tuberous and pygmy *Drosera*. Not that those are recommended as easy and common in this introduction (except one pygmy). Basically it is the author's view that *Darlingtonia*, *Dionaea*, *Drosera*, *Pinguicula*, and *Utricularia* comprise the section easy growing. Luckily the species suggested under each family are, generally speaking, indeed easy species. Having said that, as a passionate grower of *Drosera*, I do have my doubts about placing *D. adelae*, *D. regia*, and *D. slackii* in this category.

Which plants compose the section labelled "Taking things to the next level"? The answer is *Cephalotus*, *Heliamphora*, and *Nepenthes*. Again the text on these plants is solid, but it is not what I expected. I would have expected to find *N.* × *ventrata* in the first section and some more difficult species of *Nepenthes* in the second. Not a classification of all *Nepenthes* as "the next level", not to mention that some species like *N. rajah* and *N. bicalcarata* are in my opinion several levels above easy and not the next level. At this point the book misses its brief of "a guide for the more advanced grower who may have had a few successes and wishes to delve deeper into this peculiar and somewhat alien world."

It is a pity that the author chose not to include plants like *Byblis*, the Bromeliads, and *Roridula* (perhaps because of the narrow approach to carnivory I mentioned earlier?). In a beginners book I would at least have expected to have all families dealt with. But even so, where is *Genlisea* and *Aldrovanda* (I'll let *Philcoxia* slide)?

A 3-page chapter labelled "Children, beginners & education" is added, but doesn't add much beyond the very correct warning to stay away from the complete pre-packaged seed sets sold in some shops.

The book closes with resources, societies, and recommended reading. Good sources, though it pains me that my beloved International Carnivorous Plant Society is labeled as "United States".

So, what do I think of this book? In general, the book is good for the starting grower, though I would have preferred that the author had taken a broader approach to carnivory and dealt with all the regular families found in most books. The book combines texts that range from good to absolutely excellent with a set-up that sometimes is confusing to follow—things get mentioned too early or too late for my feeling. The division of easy and next level plants is not one I would have made on the family level and that makes it a bit tricky, though most of the recommended plants in the easy section would steer our novice clear of major issues.

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New cultivars

Keywords: cultivar, *Dionaea* 'Shark Mirror', *Drosera* 'Alexandrite Aster', *Drosera* 'Childhood Wishes', *Sarracenia* 'Bug Bat', *Sarracenia* 'Carolina Yellow Jacket', *Sarracenia rosea* 'Fat Chance', *Sarracenia* 'Hot Lips', *Sarracenia* 'Saurus', *Sarracenia* 'Sword Swallower'.

Drosera 'Childhood Wishes'

Submitted: 19 May 2016

In late 2014, a flowering specimen of *Drosera affinis* "Uningi Pans, Zambia" was pollinated using a white-flowered form of *Drosera spatulata*. The resulting hybrid is a unique stem-forming plant that reaches on average 7 cm high, with 4 cm leaves that spread out in all directions from the growing point. The leaves are narrow and elongate, with long petioles and thin paddle-shaped lamina that are often folded down the middle to produce a cylindrical profile. Color is bright emerald green, framed by light red tentacles; the lamina will occasionally blush light red under strong light (Fig. 1). Flower stalks are long and wiry, up to 40 cm tall, and bear small, delicate pink blooms.

The name of the plant originates from the resemblance of the spidery rosettes sitting on top of a stem to that of a dandelion seed-head, with the long, narrow stalks branching out at the tips into wide, fluffy umbrellas like the thicker lamina and spreading tentacles of the cultivar; every child has at some point made a wish on a dandelion and blown it away to the wind.

—Hawken Carlton • 4627 Mesa Verde Dr. • Greeley • Colorado 80634 • USA • hawken.carlton5@gmail.com

Figure 1: Side and top views of *Drosera* 'Childhood Wishes'. Photos by Hawken Carlton.

Drosera 'Alexandrite Aster'

Submitted: 18 April 2016

In early 2014, I crossed a specimen of *Drosera aliciae* with a *Drosera* from Lantau Island, Hong Kong that is believed to be a natural hybrid between *D. oblanceolata* and *D. spatulata*. This breeding produced a pair of hybrids with a unique appearance. The one with *D. aliciae* as the maternal parent was selected and named *Drosera* 'Alexandrite Aster' in December 2015.

This cultivar can reach in excess of 8 cm across, with a ground-hugging layered rosette of tapered leaves that resemble the flat, spreading petals of asters or windflowers. Up to a dozen or more leaves can be active at any one time. *Drosera aliciae* lends not only size to the hybrid but also greater width of the leaves, with tentacles covering more than half the leaf length (Fig. 2). The base color of the leaves is rich olive green, with scarlet tentacles adding a red halo to the leaves, especially notable when viewed against strong lighting, much like the red/green color-changing gemstone Alexandrite. Occasionally, the lamina may also obtain a slight red blush.

The inflorescences of this cultivar may reach up to 50 cm high, with a dappled indumentum of red trichomes and small glandular hairs. Flowers can be 2 cm across, a delicate mauve-pink with egg-shaped petals (Fig. 2). This cultivar is a sterile hybrid and can only be propagated by leaf, scape, or root cuttings.

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Figure 2: *Drosera* 'Alexandrite Aster' rosette (left) and flower (right). Photos by Hawken Carlton.

Dionaea 'Shark Mirror'

Submitted: 14 May 2016

Dionaea 'Shark Mirror' has a variable color, but it is green during autumn and winter. The plant is prostrate during autumn and winter and erect during spring and summer. It has external trap appendages similar to *Dionaea* 'Mirror', but the marginal teeth are like those of *Dionaea* 'Dentate Traps' and resemble the teeth of a shark (Fig. 3). Sometimes it produces normal traps without appendages.

The name *Dionaea* 'Shark Mirror' combines the name *Dionaea* 'Mirror' and the shark-like shape of the teeth.

Dionaea 'Shark Mirror' must be reproduced vegetatively to preserve the unique characteristics of this cultivar.

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Figure 3: *Dionaea* 'Shark Mirror' has traps that range from normal traps to those with external appendages of different size. Photos by Alexandre Letertre.

Submitted: 7 June 2016

Sarracenia 'Hot Lips' is a primary *S. moorei* hybrid of (*S. leucophylla* × *flava* var. *ornata*) which I made in the spring of 2005 and selected in 2008. This clone is a sibling to cultivars 'Vintner's Treasure' and 'Saurus'.

This incredibly beautiful and highly popular pitcher plant is a very vigorous and stocky grower averaging heights of 75-80 cm or more on well-established older plants (Fig. 4). Pitchers start out green overlaid with bright white areolae directly under the nectar roll extending downward some 5-8 cm. The hood is large, ruffled and bright creamy white with deep reddish purple veins approximately 10 cm wide from side to side and 10 cm long from the back to the front with dark reddish purple non-bleeding veins. The fluted mouth attains comparable sizing with the hood and has a very smooth and glossy satin appearance. There is a prominent dark purple throat patch on the inside neck of the pitcher.

As the pitchers mature the lids become much whiter and the lips become deep crimson, giving the appearance of a lipstick application. The contrast of these colors makes for a strikingly beautiful presence. Like all *S. moorei*, this cultivar produces pitchers all season with a more pronounced late summer burst of growth. These late season pitchers are not quite as big, but my personal observation over the years is that they are much more colorful.

Propagation must be done via division and cuttings in order to maintain this plant's unique features. This cultivar's epithet 'Hot Lips' was coined on Facebook on March 14, 2014 from an admirer as a suggestion that it looked like it had "hot" lips.

—Phil Faulisi • Santa Clara County • California • USA

Figure 4: *Sarracenia* 'Hot Lips'. Photo by Phil Faulisi.

Sarracenia 'Saurus'

Submitted: 7 June 2016

Sarracenia 'Saurus' is a primary *S. moorei* hybrid of (*S. leucophylla* × *flava* var. *ornata*) which I made in the spring of 2005 and selected in 2008. This clone is a sibling to cultivars 'Vintner's Treasure' and 'Hot Lips'.

This cultivar, which has created quite a stir worldwide, is a true beast of a pitcher plant reaching towering heights of 85-100 cm or more on well-established older plants (Fig. 5). High ambient humidity during the growing season ensures big, robust pitcher growth. According to my many colleagues, this is one of the single largest cultivated pitcher plants they have ever seen. It's certainly the largest I have ever created to date. There may be taller pitcher plants out there, but the overall girth and heftiness of this cultivar carries its weight as one of the biggest man made ever. It is a spectacle of the carnivorous pitcher plant kingdom.

Pitchers start out green overlaid with a medium red with a scattering here and there of white areolae directly under the nectar roll and extending downward 4 to 7.5 cm. The hood is large and heavily ruffled approximately 10-15 cm wide from side to side and 10-15 cm long from the back to the front. The heavily fluted mouth attains comparable sizing with the hood and has a very smooth and glossy appearance.

As the pitchers mature they take on a deep plum/red color from the lid to approximately two thirds the length down the pitcher tube. The entire inside of the pitcher becomes a shimmering "metalized" rich, dark plum that has that highly polished and iridescent look in full sunlight.

Flowers are red and typical for a *S. moorei* and arise on stalks equally as tall as the pitchers. In late summer a secondary set of pitchers are produced that are also very tall and colorful, but not as robust in girth as the spring growth.

Propagation must be done via division and cuttings in order to maintain this plant's unique features. This cultivar's epithet 'Saurus' was coined by my friend and colleague Rob Co in 2009 as a reference to its dinosaur huge proportions.

—Phil Faulisi • Santa Clara County • California • USA

Figure 5: *Sarracenia* 'Saurus'. Photos by Calen Hall.

Sarracenia 'Sword Swallower'

Submitted: 7 June 2016

Previously released as (*S. moorei* "Phil" clone 3), *Sarracenia* 'Sword Swallower' is a primary *S. moorei* hybrid of (*S. leucophylla* × *flava* var. *rubricorpora*) which I made in the spring of 2002 and selected in 2008.

This is a very vigorous growing pitcher plant averaging heights of 75-80 cm or more on well-established older plants and approximately 5-7 cm wide at the mouth opening (Fig. 6). The hood is heavily marbled with thick pink/red veins and large light pink areolae, heavily ruffled, and approximately 7.5 cm wide from side to side and 7.5 cm long from the back to the front. The lip is thin and slightly rolled.

As the pitchers mature, the color becomes a deeper blood red extending down the upper 1/3 of the pitcher, with a bright lime green interior suffused with dark red veins which makes for a striking color combination.

Flowers are red and typical for a *S. moorei*. Pitchers are produced all season, with the largest coming with the new spring growth. Late season pitchers are somewhat smaller, but no less colorful.

Propagation must be done via division and cuttings in order to maintain this plant's unique features. This cultivar's epithet 'Sword Swallower' was coined by my close friend and bogging buddy Trey Hale of Tallahassee, Florida as a suggestion that the tall slender pitchers looked like they could easily swallow a sword.

—Phil Faulisi • Santa Clara County • California • USA

Figure 6: *Sarracenia* 'Sword Swallower'. Photo by Phil Faulisi.

Submitted: 23 June 2016

Sarracenia 'Bug Bat' is a pitcher plant that was hybridized about 1990 by Larry Mellichamp at University of North Carolina at Charlotte Botanical Gardens as part of a *Sarracenia* breeding program. *Sarracenia* 'Bug Bat' is most likely a cross of *Sarracenia* (*alata* × *psittacina*) × *minor* var. *okefenokeensis*. The plant shows hybrid vigor in forming a robust clump of upright, slightly diverging tubular pitchers to 40 cm, green at the bottom and cinnamon red toward the tip with tiny white windows in the hood back (Fig. 7) thanks to the *S. minor* parent. The reddish hood of the giant pitchers darkens in the summer sun and generally forms an almost closed mouth.

The name Bug Bat was coined about 2005 by David Crump alluding to the shape of the pitchers resemblance to baseball bats, and then associated with catching bugs.

Must be reproduced asexually to retain the cultivar traits.

—Larry Mellichamp • 3036 Ventosa Drive • Charlotte • North Carolina 28205 • USA • lmellichamp@carolina.rr.com

Figure 7: *Sarracenia* 'Bug Bat'. Photos by Larry Mellichamp.

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Plant not included

Sarracenia 'Carolina Yellow Jacket'

Submitted: 23 June 2016

Sarracenia 'Carolina Yellow Jacket' is a cross between *S. purpurea* forma *heterophylla* and S. *purpurea* forma *heterophylla* × *flava* produced at the University of North Carolina at Charlotte Botanical Gardens about 1990 as part of a *Sarracenia* breeding program.

Sarracenia 'Carolina Yellow Jacket' is unique in that it survives the hot summers of North Carolina. It is quite a rare chance seedling involving anthocyanin free *S. purpurea* subsp. *pupurea* and an all yellow *S. flava*, and arose in a batch of seedlings not all of which were anthocyanin free. It forms a very vigorous rapidly-enlarging clump with decumbent yet upright, very thick-textured, pitchers, to 30 cm long, elongated and nearly hairless, with the hood margin often pinched in or touching over the mouth (Fig. 8), displaying the fact that it is two parts northern *S. purpurea* forma *heterophylla* and one part *S. flava*. The pitcher color is uniform, appearing from Granny Smith apple-green to rich chrome or lemon yellow depending on the time of year and growing conditions. The flowers are produced abundantly in the clump (one per growth) and all parts are green to bright yellow.

The name Carolina Yellow Jacket was coined about 2005 by David Crump alluding to the bright yellow color of the leaves and flowers and that it arose in North Carolina.

Must be reproduced asexually to retain the cultivar traits.

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Figure 8: *Sarracenia* 'Carolina Yellow Jacket'. Photo by Larry Mellichamp.

Sarracenia rosea 'Fat Chance'

Submitted: 23 June 2016

Sarracenia rosea 'Fat Chance' is a selection of a *Sarracenia rosea* Naczi, Case & R.B. Case wild collected about 1985 in the vicinity of Perdido, Alabama by Larry Mellichamp for the University of North Carolina at Charlotte Botanical Gardens. Synonym of the species *Sarracenia purpurea* subsp. *venosa* var. *burkii*.

Sarracenia rosea 'Fat Chance' is typical of the species, which grows along the Gulf Coast of the Southeastern U.S. from Mississippi to Florida, in forming a rosette of decumbent somewhat thick-textured slightly hairy (hairs <1 mm long) pitchers with erect wavy-margined hood and gaping mouth with very thick rim. The margins of the hood often pinch together and may touch, as is often seen in *Sarracenia purpurea*, though the red veining on green tissue is less prominent. The pitchers are more likely to die off after a severe winter than typical *S. purpurea*. The significant difference for the cultivar is that the pitchers are more bulbous, or fatter, than typical for the species, and remain very dark red the whole season when grown in sun (Fig. 9). The flower is typical of the species, with pink petals on a relatively short scape to 25 cm.

The name Fat Chance was coined about 1986 by Larry Mellichamp alluding to the fatter shape of the pitchers, and the "fat chance" that you might get one if you ask me.

Must be reproduced asexually to retain the cultivar traits.

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Figure 9: *Sarracenia rosea* 'Fat Chance' pitchers and flowers. Photos by Larry Mellichamp.

Carnivorous plant cultivar names registered in 2015

Dionaea 'Carniplant' G.Gutierrez, Carniv.Pl.Newslett.44:32 (2015)	9 Apr.
Dionaea 'Farou' A.Dalmais, Carniv.Pl.Newslett.44:32 (2015)	9 Apr.
Dionaea 'Purple Haze' J.M.Kotleba, Carniv.Pl.Newslett.44:33 (2015)	9 Apr.
Dionaea 'Spotted Hyena' T.Sicking, Carniv.Pl.Newslett.44:93 (2015)	5 May
Drosera 'Dork's Pink' Hancock & Lowrie, Carniv.Pl.Newslett.44:18 (2015)	9 Apr.
Drosera 'Helen' S.Morley, Pl.Carniv.37:6 (2015)	22 Sep.
Nepenthes 'H.R.Giger' M.Kaelin, Carniv.Pl.Newslett.44:36 (2015)	9 Apr.
Sarracenia 'Amphibien' A.Sanguet, Carniv.Pl.Newslett.44:159 (2015)	22 Sep.
Sarracenia 'Cooke's Bayou Red' J.Hummer, Carniv.Pl.Newslett.44:158 (2015)	22 Sep.
Sarracenia 'Dantadelle' A.Sanguet, Carniv.Pl.Newslett.44:162 (2015)	22 Sep.
Sarracenia 'Elvis Presley' J.Hummer, Carniv.Pl.Newslett.44:159 (2015)	22 Sep.
Sarracenia 'Legacy' R.Co, Carniv.Pl.Newslett.44:35 (2015)	9 Apr.
Sarracenia 'Metallized' D.Righetti, Carniv.Pl.Newslett.44:156 (2015)	22 Sep.
Sarracenia 'Rubis Rare' A.Sanguet, Carniv.Pl.Newslett.44:161 (2015)	22 Sep.
Sarracenia 'Troll' S.Morley, Pl.Carniv.37:10 (2015)	22 Sep.

Erratum

Correction of the reference to the basionym *Pinguicula longifolia* Ram. ex DC. subsp. *caussensis* Casper

Aymeric Roccia • aymeric.roccia@live.fr

In his previous work about temperate butterworts (Roccia *et al.* 2016), the present author and his colleagues elevated *Pinguicula longifolia* Ram. ex DC. subsp. *caussensis* Casper to species rank. However, they cited Casper's revision of the Eurasian *Pinguicula* (1962) as the reference to the basionym. This description is lacking a type designation, thus the name *Pinguicula longifolia* Ram. ex DC. subsp. *caussensis* Casper was not published validly there. Later, in his monograph of the genus *Pinguicula* (1966), Casper cited the specimen "Aveyron, Vallée de la Dourbie (leg. Coste-!W)" as the type, making his new subspecies now validly published.

In this erratum, the present author would like to correct this mistake and cite Casper (1966) as the correct reference to the basionym *Pinguicula longifolia* Ram. ex DC. subsp. *caussensis* Casper: *Pinguicula caussensis* (Casper) Roccia, *comb. et stat. nov.*

Basionym: *Pinguicula longifolia* Ram. ex DC. subsp. *caussensis* Casper, *Bibliotheca botanica*, 127/128:154, 1966

References:

Casper, S.J. 1962. Revision der Gattung *Pinguicula* in Eurasien. Feddes Repertorium 66:1-148

Casper, S.J. 1966. Monographie der Gattung *Pinguicula* L. Bibliotheca Botanica 127/128:1-209

Roccia, A., Gluch, O., Lampard, S., Robinson, A., Fleischmann, A., McPherson, S., Legendre, L., Partrat, E., and Temple, P. 2016. *Pinguicula* of the Temperate North. Poole: Redfern Natural History Productions, 349 pp.